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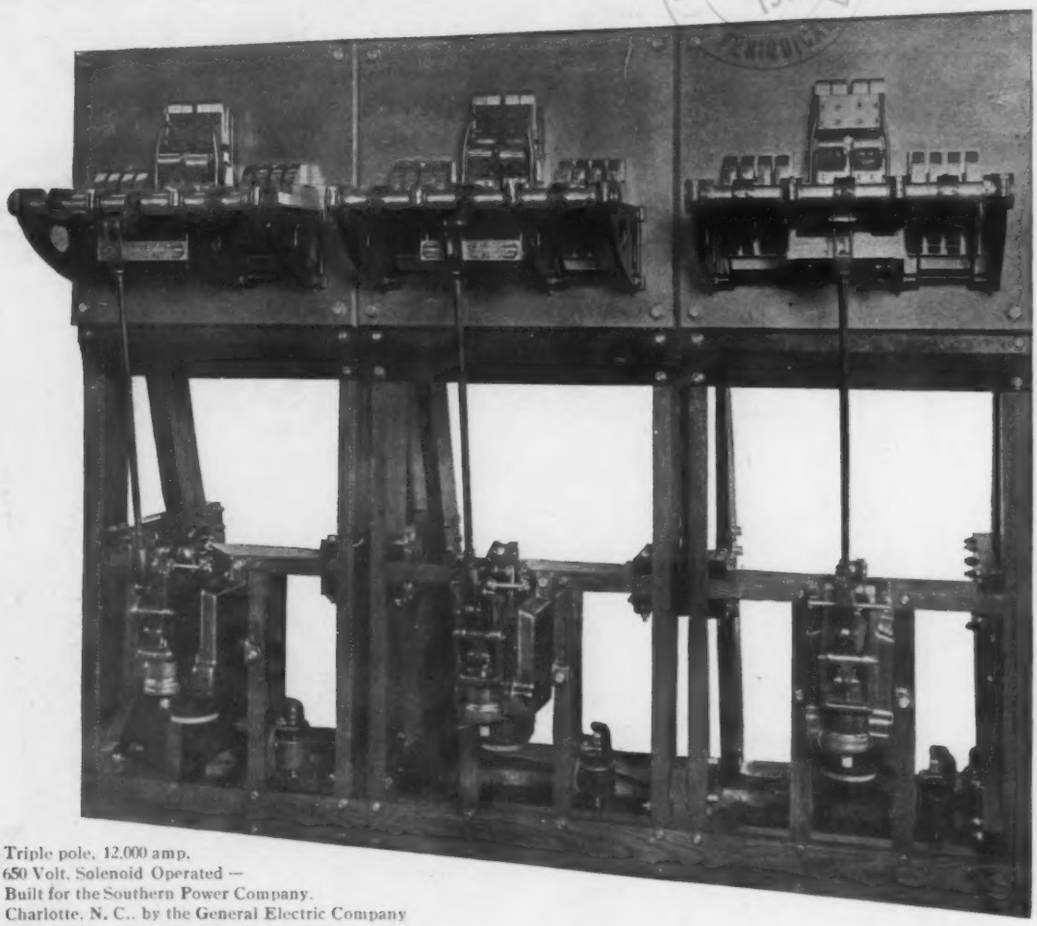

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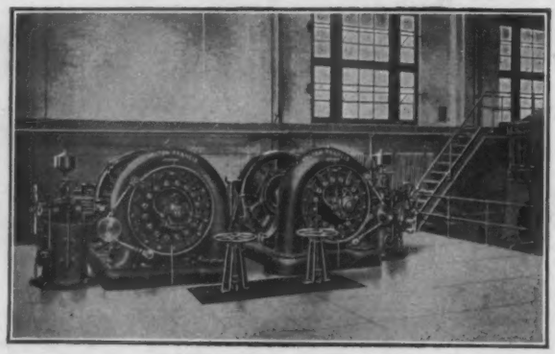

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*Alameda	27,000	Durham	500	Martell	25	San Anselmo	2,500
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††Alta	200	**Easton	500	**Marysville	6,250	San Carlos	100
Alvarado	200	**East San Jose	1,500	Mayfield	1,500	**San Francisco	450,000
Amador	200	Eckley	20	**Menlo Park	1,500	**San Jose	40,000
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††Auburn	2,050	Elmhurst	2,500	**Milbrae	300	San Lorenzo	100
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Belvedera	350	**Emeryville	2,000	Mokelumne Hill	150	**San Quentin Prison	1,600
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Brighton	100	Glenn Ellen	500	Newman	1,000	Sebastopol	2,000
Broderick	500	Gold Run	100	Niles	800	Selby	100
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Concord	1,500	Larkspur	950	Pleasanton	2,000	Tracy	1,200
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Crockett	2,500	Kentfield	200	Richmond	10,000	Vallejo Junction	10
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Davenport	1,000	†Live Oak	200	‡Rocklin	1,050	Wheatland	1,400
Davis	750	Livermore	2,250	Rodeo	100	Winters	1,200
Decoto	350	‡Loomis	150	†Roseville	345	**Woodland	3,500
Dixon	1,000	Los Altos	200	Ross	900	Yolo	350
Dobbins	50	Los Gatos	3,000	***Sacramento	52,000	**Yuba City	1,900

*Gas only: **gas and electricity; †electricity, gas, and water: ‡electricity and water: ***gas, electricity, and street car service: all others, electricity only.

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Gas	33	988,900
Water	17	43,415
Street Car	1	52,000

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½ the size of all the New England states combined

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POWER AND GAS
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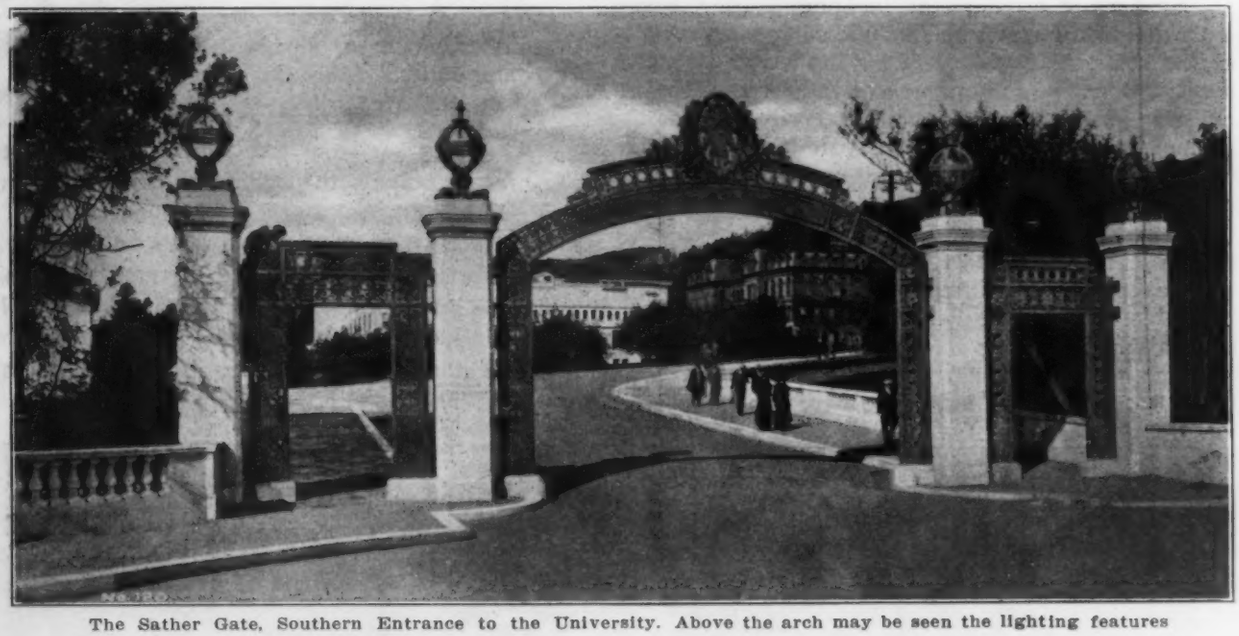
HEATING PLANT, UNIVERSITY OF CALIFORNIA

BY W. B. MEL.

Dating back to the year 1906, when the present central Power Plant and heating system of the University of California commenced operating as such, supplying steam heat to California Hall and Harmon Gymnasium, there has rapidly grown up with the University's increasing needs the present system supplying heat for over twenty of the buildings and light and power for practically every building on the Campus.



The Sather Gate, Southern Entrance to the University. Above the arch may be seen the lighting features

A faithful history would perhaps begin by describing the wood burning stoves and oil lamps in the first building, South Hall, occupied in 1873, and gradually cover the successive changes naturally following along with the additional buildings and occupied portions of the Campus, but aside from a few remarks covering this period, the article will be devoted mainly to a description of the system as it stands today.

Electricity first appeared on the Campus at Berkeley, for lighting purposes in 1896, when, through the munificence of Mrs. Hearst, the Bacon Library was wired and lighted from a 2 pole, 20 kw. Edison Type '87, 110 volt machine, then a part of the Electric Laboratory located in the Mechanics Building. A little later the night lighting in the Library was supplied from a 30 kw. 133 cycle, single phase, 1100 volt, alternator, also a part of the Laboratory equipment at the Mechanics Building. The line voltage of 1100 volts was stepped down at the Library through a transformer to 110 volts. During the day time switching was arranged so that what lights were necessary could be run from the direct current Edison machine.

At the same time a 10 light Thompson-Houston arc machine together with twenty open arc lamps were presented to the University by the Oakland Gas Light & Heat Company through John A. Britton and were installed on a series arc line around the Campus. The 10 light machine was run in series with a 15 light Wood machine, both being driven by a straight line engine located in the Mechanics Laboratory. From

Lover's Lane. Beautiful walk at western entrance to University.

this beginning the present electric light and power system grew, the arc system having been changed over first to a 25 light Thompson-Houston machine and later, in 1904, to an alternating current arc line with a larger number of enclosed arcs.

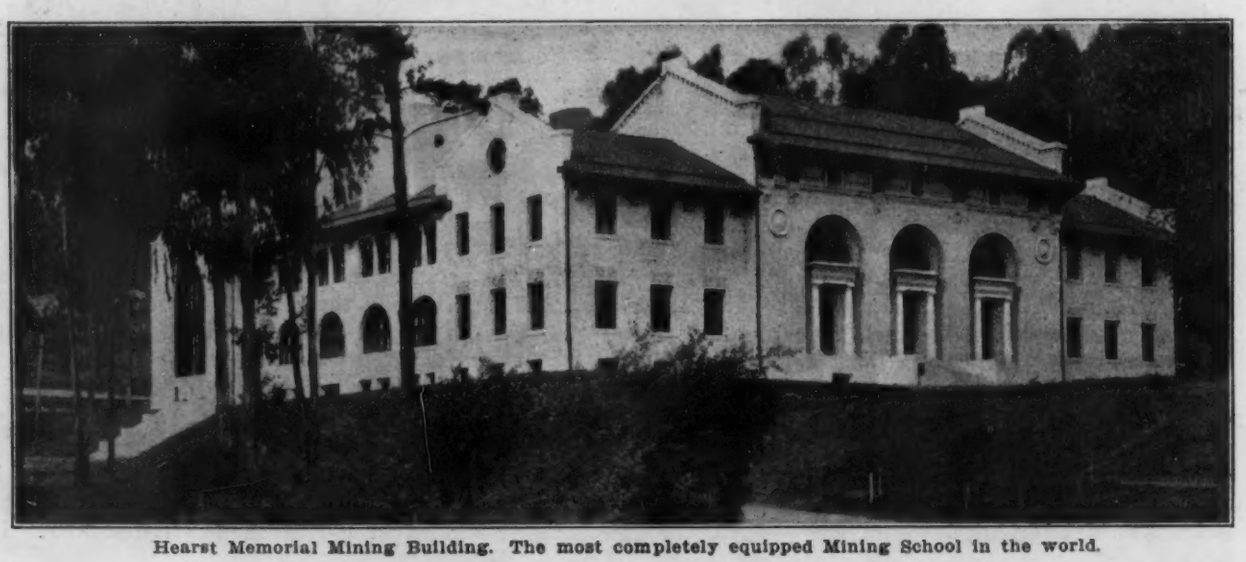
First Heating Systems.

Systematic attempts at building heating began with the erection of small individual boilers, usually of the sectional type, for either hot water or steam service, with pipe-coil or cast iron radiators. The first one was placed in the Bacon Library Building at the time of its erection in 1878 and some of the old radiators installed at that time are still in service. They are of the vertical cast iron tube type really acting as direct-indirect radiators. Also there were placed large pipe coils in boxes under the first floor. The heated air was passed up through floor registers into the central portion of the building. These registers are still faithfully serving as part of the present heating system. Other buildings as well were supplied with small heating boilers but these have gradually been eliminated one by one until at present only two buildings on the Campus are heated locally; namely, the Architectural Building, situated at the north entrance to the grounds and equipped with a cast iron sectional steam boiler and single pipe steam radiation system, and the President's house, located on the extreme north edge of the Campus, as shown in the full page map accompanying this article. In this building cast iron radiators are supplied with heat from a sectional hot water boiler.

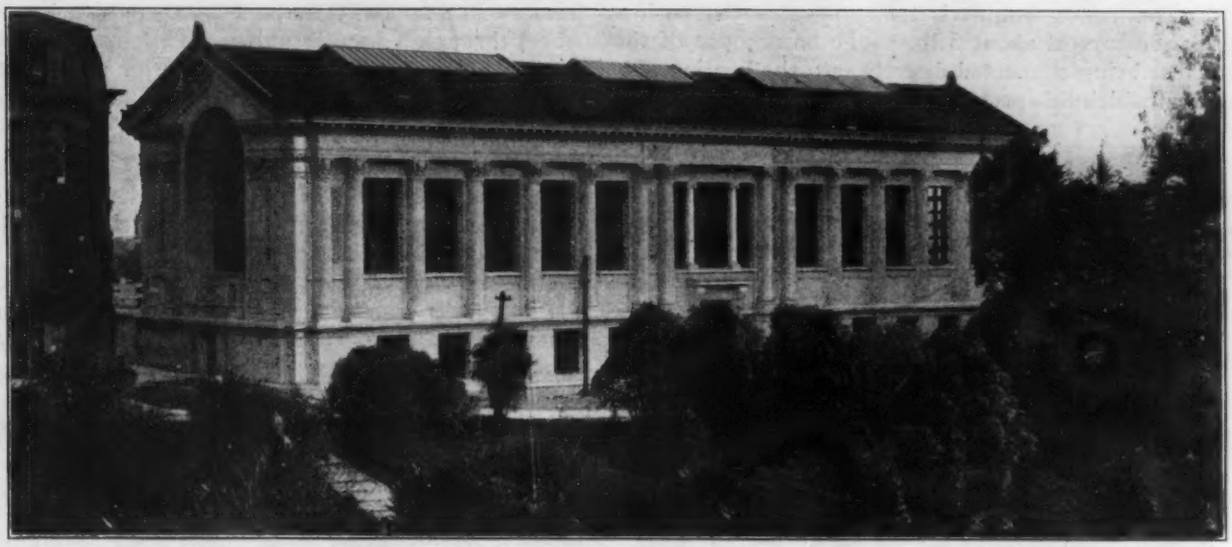
Present Power Plant.

The plant itself was erected in 1904 with three of the present boilers, the engine and necessary auxiliaries, but operation was not commenced until the fall of 1905 when, as mentioned above, heating was started for California Hall and Harmon Gymnasium. With the present rate of increase the plant will have to be duplicated within a period of two or three years.

The equipment now in service and the operating arrangement is as follows:



Hearst Memorial Mining Building. The most completely equipped Mining School in the world.



California Hall and Boalt Hall of Law. New buildings under the recent heating installation.

Boilers.

The power plant boilers consist of four Babcock & Wilcox water-tube boilers, each with 456 4 in. 16 ft. tubes and 42 in. drum, giving a heating surface of 1270 sq. ft. These operated at 140 lb. pressure, supply steam to the engine, auxiliaries, and heating system. All boilers are equipped with Peabody furnaces for oil burning with Champion burners, oil for which is pumped from a 13,000 gallon tank, located on the bank of Strawberry Creek 50 feet from the plant. The pumping equipment consists of two Snow steam pumps 3x2x3, one being kept in reserve.

The oil pump exhaust passes through a small reheater beneath the pumps. This heats the oil to about 125 degrees F. before delivery to the burners. The exhaust then passes out through a coil in the main oil tank and discharges into the creek.

B. and W. superheaters deliver the steam to the main header under a superheat of from 60 to 120 degrees, depending on the load conditions.

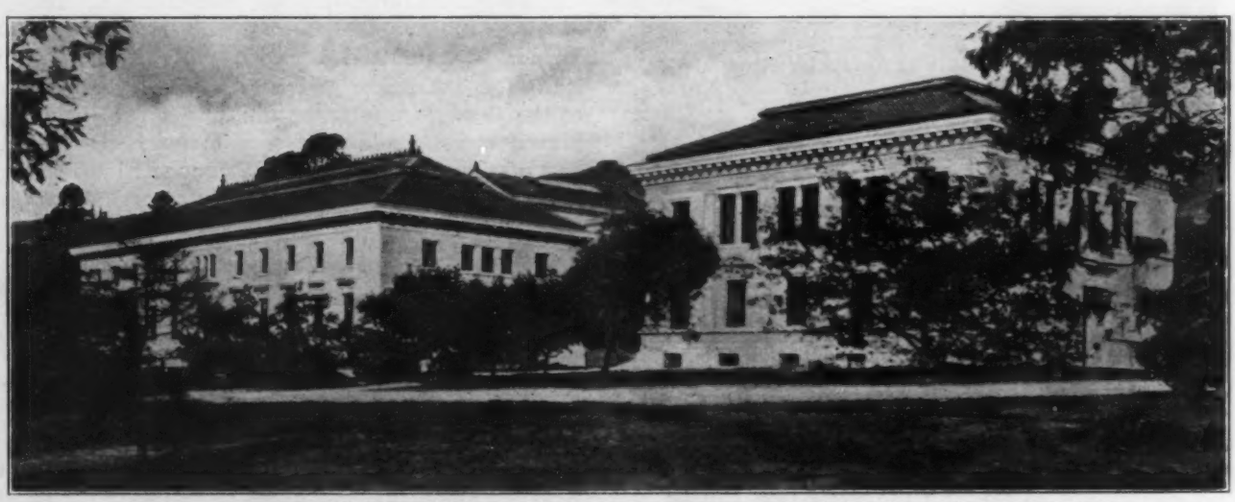
When necessary, the above boilers may be supplemented by two B. and W. boilers in the Mechanics Building on the opposite side of the Campus. These units have been installed and in operation since 1894 and 1898. Primarily, however, they are used to furnish steam for laboratory practice in the Mechanics Building and also to furnish 100 lb. steam to the Mining Building Laboratory to run a large air compressor.

Vacuum Pumps and Feed Water Pumps.

An Epping Carpenter 12x16x16x18 air circulating pump arranged with two air cylinders and one steam cylinder, arranged in tandem, handles all returns from the heating system maintaining from 12 in to 20 in. of vacuum on the system and forcing the return water into a horizontal tank receiver acting as a hot well. The returns are reheated by steam from the auxiliaries passing through a pipe coil in the receiver and discharging into the creek. The "return water," together with the necessary make up water is raised by two Snow Pump Co.'s 5¼x3½x3 feed pumps and discharged into a Hoppe purifier placed 4 feet above the boilers. From here the water runs by gravity to the boilers, the purifier being under boiler pressure.

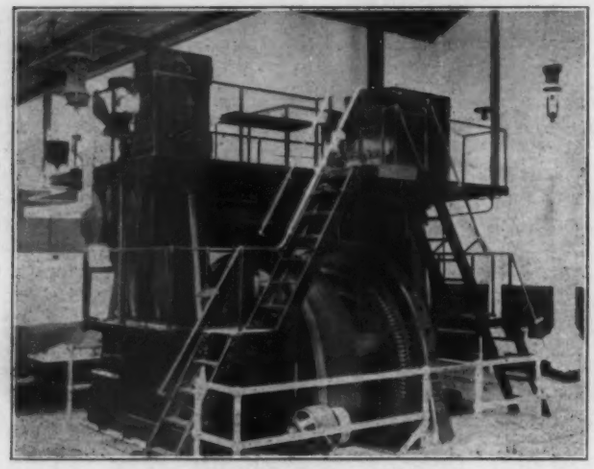
Engines.

The engine, manufactured by the McIntosh-Seymour Co., is of the vertical cross compound type 12 in. x 26 in. x 30 in. stroke. It was originally designed



The Doe Library Building. This magnificent new structure at the University is to be given two stars in Baedeker's American Guide.

as a condensing engine but is now operated with a back pressure of about 5 lb. gauge on account of the exhaust being connected directly into the heating system on which this pressure must be maintained.

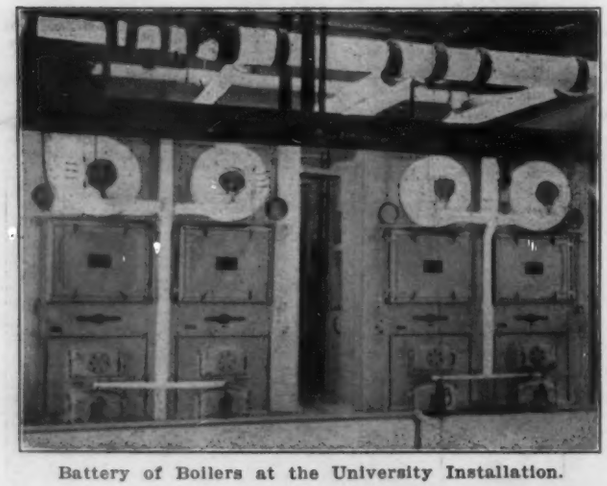


Power Installation at the University.

Between the low and high pressure cylinders is a reheater which delivers the steam to the low pressure cylinder under a slight superheat and at a pressure of about 30 lb. Combined with the engine governor is a motor operated McIntosh-Seymour speed changing device. A double throw switch on the exciter panel gives the operator control of this device and a variation of four or five revolutions per minute may be obtained when bringing the generator up to synchronism for parallel operation.

Generator.

The 250 kw. generator made by the Allis-Chalmers Company is of the revolving field type, having 48 poles and 72 field coils, running three phase star connected with neutral grounded. Normal load current is 28.9 amperes per phase with a terminal voltage of 4000 volts.



Battery of Boilers at the University Installation.

Excitation for the field is furnished from a motor generator set run either from the Berkeley Lighting Company's service, or the generator itself but should this source fail at starting the excitation can be had from a small 10 kw. generator driven by the main flywheel through a friction pulley. This may be clearly seen in the picture showing the interior of the power equipment.

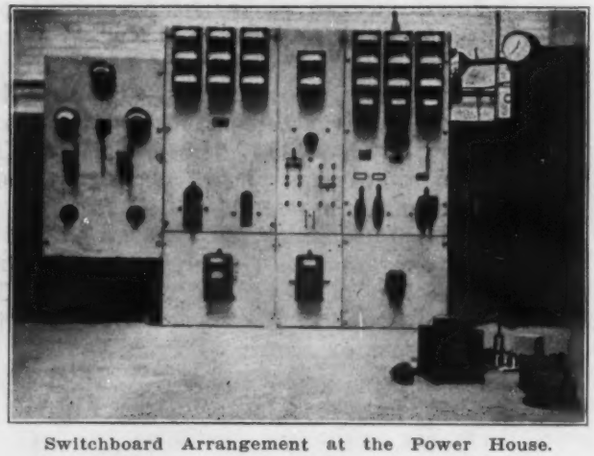
Switchboard.

An illustration in this article shows the switching arrangement. Six panels control in order from left to right as follows: (1) The direct current 220 volt three wire service, (2) Berkeley Lighting Company's incoming service, (3) the Campus distribution service, (4) an exciter panel for the generator, (5) the generator service, and (6) a starting panel for the motor generator. Oil switches are so arranged that the upper and lower Campus lines are separately controlled and either may be carried by the University's service or the Berkeley service.

As shown the three phases of both services are metered by full sets of indicating and integrating meters. Besides these panels, there is a separate panel board for the arc lighting on the Campus.

Motor Generator Set.

This set, consisting of two 50 kw. Westinghouse d.c. 110 volt generators operated in series for 220 volt 3 wire distribution, is driven by a 2300 volt 2 phase induction motor, direct connected through flexible couplings.

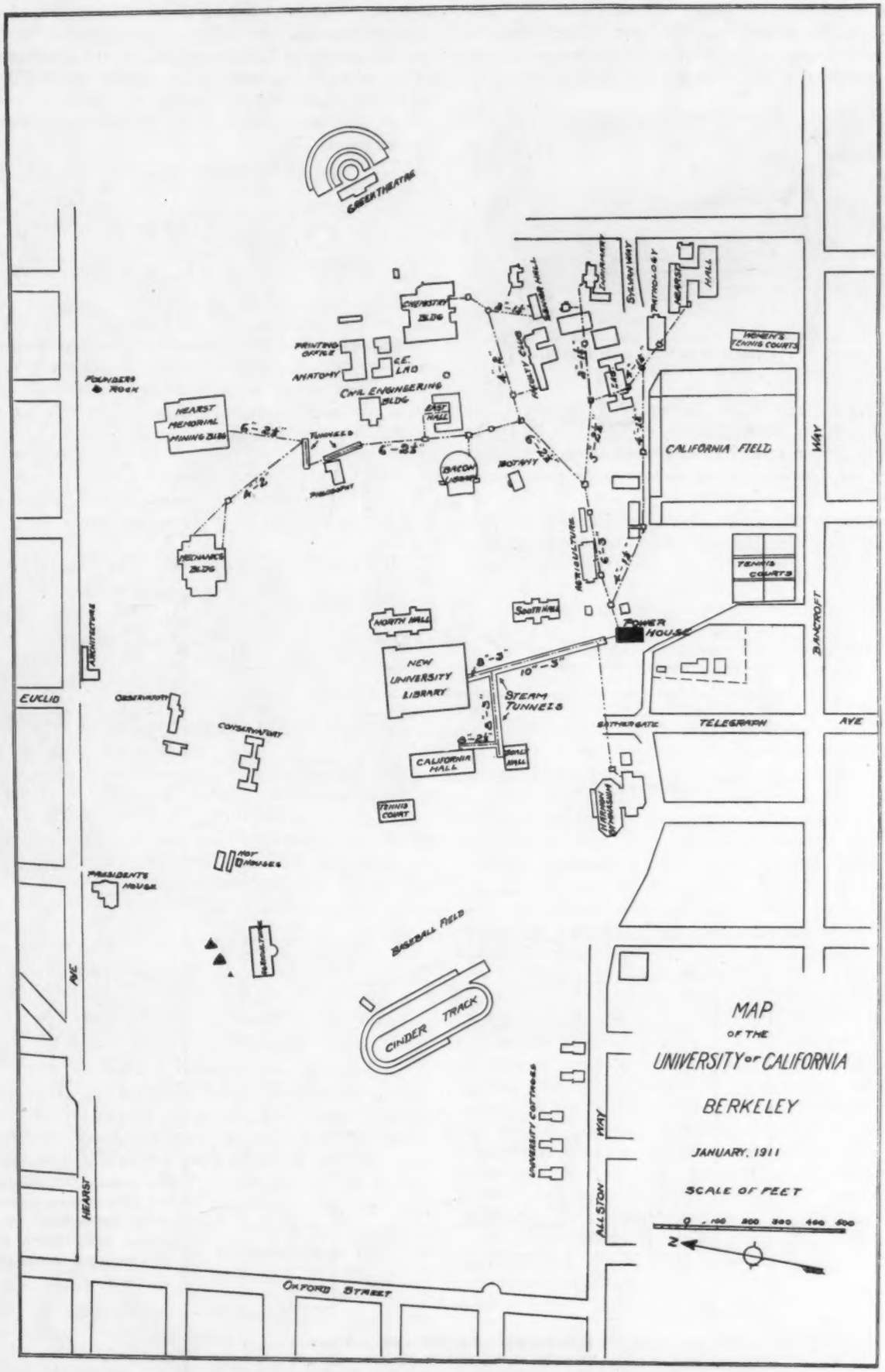


Switchboard Arrangement at the Power House.

To supply this two phase current for the induction motor, a 25 kw. 4000 to 2300 volt Hornberger transformer is connected between two of the 4000 volt leads for one phase and the 2300 volts from neutral to the third wire is taken for the second phase. This arrangement, made necessary through the failure of one of the two 75 kw. Scott connected transformers some time ago, has given satisfactory service ever since.

Heating System.

Steam distribution for Campus heating is divided into two separate parts, the lower line, providing for California Hall, Boalt Hall, Harmon Gymnasium, and the new University Library, is operated under a pressure of from 4 to 7 lb. This steam is taken from the engine exhaust when the engine is running and if this is not sufficient, as is often the case in very cold weather, sufficient "make up" to maintain the pressure



Map of Campus Showing Underground Mains and Tunnels of University Heating System.

is taken direct from the boiler, a Mason reducing valve making the reduction from the 140 boiler pressure. The pipe for nearly all of this lower Campus distribution is carried in tunnels from the plant to the buildings. The upper Campus is heated by a steam line using live steam reduced from 140 lb. to 35 lb. by an automatic Mason reducing valve and at each separate building the steam is again reduced to a pressure of about 5 lb. for the radiators.

A Portion of the Heating System Crossing Strawberry Creek.

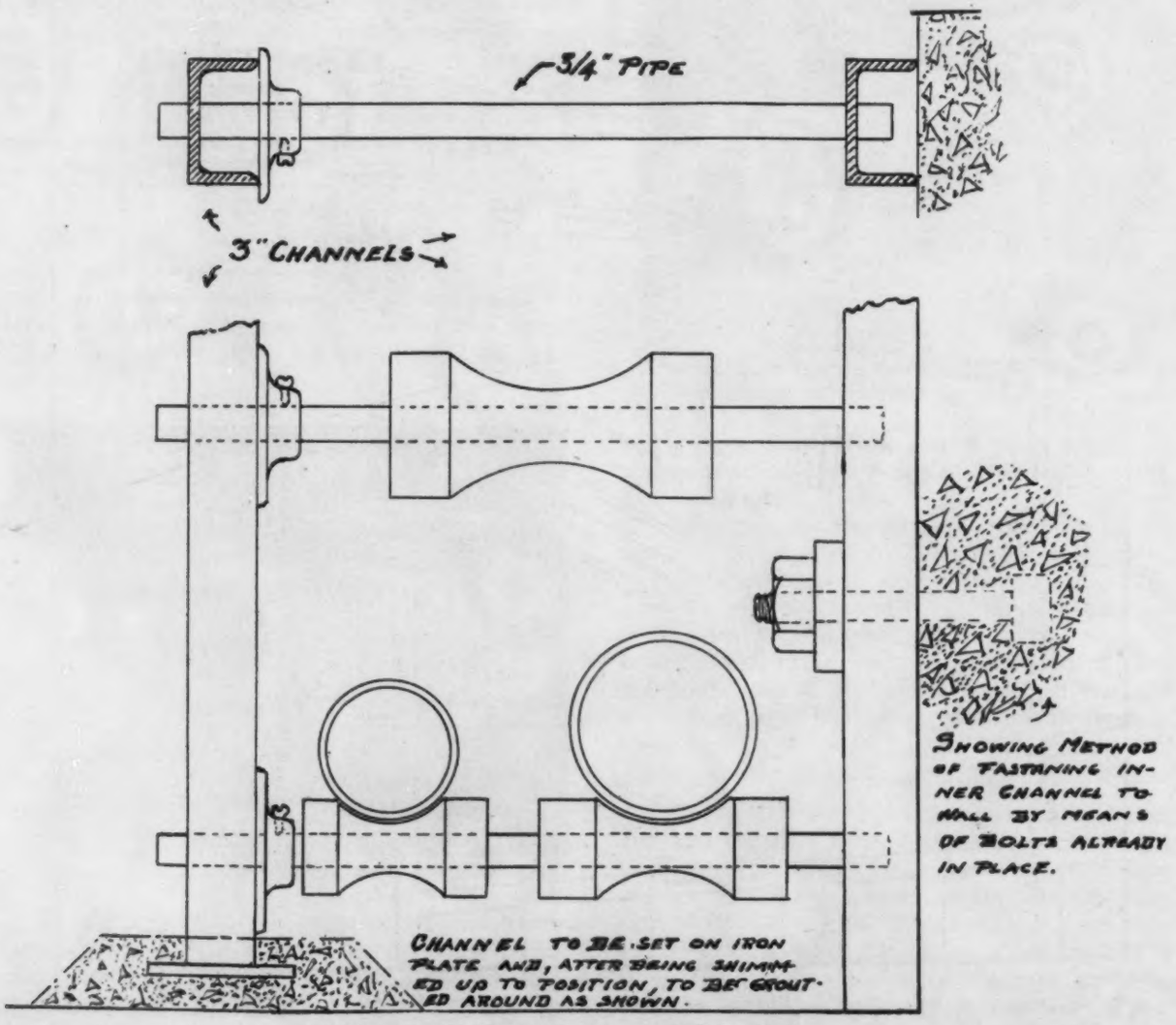
As already mentioned, this upper line is connected by a 4 in. line with the Mechanics boilers and these, in case of heavy load or when ever the main boilers have to be shut down for repairs, may be used for Campus heating.

Expansion in both steam and return pipes is taken up by sliding expansion joints placed in the 20 manholes. Anchors on the mains, subdivide the expansion so that not more than 200 ft. of pipe is expanded into any one joint.

The type of construction first used, for buried lines, placed the pipes, steam and return, in a plain wooden box of 2 in. redwood, both pipes being covered with 1 in. asbestocel of 85 per cent magnesia covering and allowed to expand on iron rollers placed at intervals of about 15 ft. on the bottom of the box.

This method has been entirely replaced within the last five years, all lines laid since then having been covered with 1 in. thickness of 85 per cent magnesia, wrapped with canvas and painted with a water proof paint. The whole is then enclosed in a salt glazed sewer tile large enough to allow a 1 in. free air space around the covering. The 2 ft. tile sections have their joints cemented to prevent seepage water from getting in around the pipe and covering a 4 in. porous drain tile is placed in the trench under the main tile to carry as much as possible of this seepage water away from the lines.

The expansion is provided for by placing tile tees


3/4" PIPE
3" CHANNELS
SHOWING METHOD OF FASTENING INNER CHANNEL TO WALL BY MEANS OF BOLTS ALREADY IN PLACE.
CHANNEL TO BE SET ON IRON PLATE AND, AFTER BEING SHIMMED UP TO POSITION, TO BE GROUTED AROUND AS SHOWN.

Clever Design Used in Underground Piping System.

at intervals of about 12 feet. The tee opening turned down and usually resting on a concrete base, contains a roller stand and roller on which the pipe rests and travels in expansion.

Some idea of the amount of heating supplied by the lower campus lines alone may be gained from the following data:

Building	Direct Heating	Indirect Heating
California Hall		1,700 Sq. Ft.
University Library	5,900 Sq. Ft.	1,700 Sq. Ft.
Boalt Hall	800 Sq. Ft.	750 Sq. Ft.
Harmon Gymnasium		700 Sq. Ft.
Total	6,700 Sq. Ft.	4,850 Sq. Ft.

In addition to this, steam is supplied to heat water for 150 showers in Harmon Gymnasium and hot water at the basins in all four buildings.

Tunnels.

Within the last two and a half years, the University has added to its heating and power system over 1000 feet of tunneling to provide for steam pipes and electric cables. These tunnels are located as shown in the map of the Campus and consist of 800 feet of concrete construction 6 ft. 6 in. high and 5 feet wide connecting the power plant with the new University Library, Boalt Hall and California Hall. Besides these there have been added three smaller concrete tunnels having an opening of 4 ft. x 4 ft. to carry steam pipes and cables under the permanent road recently completed and running in front of the new Library and past the Mining Building. These avoid the possibility of ever having to tear up the permanent roads in case of pipe line failures.

The method of supporting steam pipes and returns is shown in the diagram. The supports are placed at intervals of 11 feet and at suitable intervals heavy anchors imbedded in the concrete walls and sliding expansion joints are provided to care for the expansion.

The same pipe support construction is used between the power plant and the tunnel entrance across the creek. Two concrete piers about 18 feet apart and on either bank carry the uprights as shown.

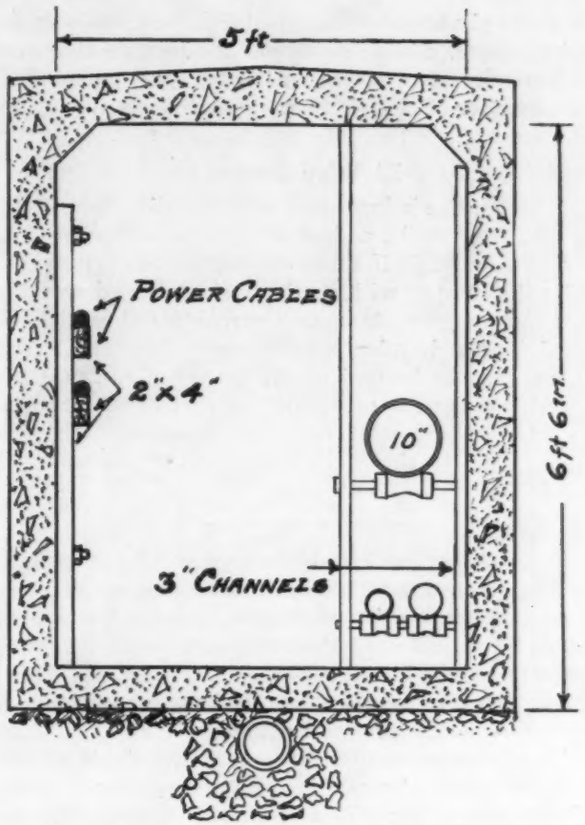
Throughout these tunnels is a full system of conduit lighting controlled by three way switches at each end of each tunnel section, the lights being spaced about 20 feet apart in incondulets.

Electric Distribution.

Up to the summer of 1909 all distribution of electric service was made from the Mechanics Building plant where the transformers, switchboards, motor generator and generators were installed. At that time the transfer was made to the power plant on the opposite side of the Campus of the above apparatus with the exception of the generator, and the equipment installed about as it stands at present, the power plant generator switchboard being combined with the others.

The character of electric distribution consists of pole line, power cabling run in iron pipe underground, and in 4-duct vitrified conduit..

This includes approximately a mile run on poles up to the Greek Theatre and on up Strawberry Canyon, supplying lights and power to the Dairy Barn,



Cross-Section View of Tunnel, Showing Clever Design of Pipe Rests.

Swimming Pool and new Hog Serum Laboratory recently completed above the Swimming Pool.

Up to a year ago the distribution was 2300 volt 2 phase, obtained from the Berkeley Lighting Co., 4000 v. power through two Scott connected 75 kw. transformers and from a two phase 2300 volt generator in the Electric Laboratory. At the time of the change from the Mechanics Building to the Power Plant and in order to continue this service the present generator was specially tapped, one phase being taken from the neutral to one 4000 volt lead, giving 2300 volts, and the other phase taken from two taps brought out from the other two windings using only 14 of the 24 coils on each winding, thus giving 2300 volts at 94 degrees phase displacement.

In the summer of 1910 all "high tension" distribution was changed over from two to three phase. This change entailed considerable work and scheming to accommodate the various motors, transformers generator, etc., to the new service, but the change was effected without any mishaps and without any serious interruptions of service. To do this, a number of two-phase induction motors had to have their windings reconnected for the three phases. This was done some time previous to the change and the motors were operated three phase from Scott connected transformers on the two-phase line.

Motor Service.

Over forty-five motors furnish power for different purposes in the various buildings, exclusive, of course, of those used for testing purposes in the laboratory equipments. The motors are single-phase, two-phase,

and three-phase induction of 110, 220 or 440 voltage. Besides these, a number of smaller motors and storage batteries are operated on the direct current line, and a number of electric furnaces and stereopticon lanterns are used in the different departments.

Lighting Service.

This service is furnished to practically every building on the grounds, and in addition, a series arc line, over two and a half miles in length, completely encircles the campus with its thirty-six enclosed arcs and six series tungsten lamps. Current for these is furnished from a fifty lamp, 6.6 ampere General Electric arc transformer located in the Power Plant. Of the six series tungstens mentioned as part of the arc system, four of 250 watt capacity, illuminate the new Sather Gate at the Telegraph Avenue entrance as shown.

CALIFORNIA OIL INDUSTRY.

The California Oil World has compiled some interesting figures on the great oil industry in the Golden State. It is estimated that it would require an unbroken train of oil tank cars reaching from San Francisco to Chicago to haul at one load the present annual output of the California oil fields.

The present annual output of the fields of the state at 80,000,000 barrels, is at least three-eights of the entire output of the United States. Figuring the capacity of the tank cars at 300 barrels each and each forty feet in length with the usual intervening coupling space it would require, using round numbers, 267,000 cars to carry this amount and with the necessary compliments of locomotives to pull them such a huge train would reach from San Francisco to Chicago, a distance of over 2000 miles. Or it would make 8900 trains if cut up into thirty cars each.

The investment of the California oil industry represents $200,000,000. The value of Standard Oil's interest in the state is $50,000,000.

ELECTRICITY AND THE CODLING MOTH IN THE GREAT NORTHWEST.

BY AUGUST WOLF.

Electricity as an agency to destroy the codling moth is the latest innovation of modern apple orcharding in the Spokane valley, where W. M. Frost, inventor of the device, and J. C. Lawrence, a practical grower of Spokane, made what is declared to be the first demonstration of its kind in the world the evening of August 18. The test was made in a six-years' old orchard at Opportunity, Wash., where a score of second-brood moths and hundreds of green aphis were killed in a few minutes. The apparatus consists of a storage battery to charge incandescent light globes of six-candle power, which are netted with fine steel wires, coated with copper and tin, alternately. Attracted by the bright light in the tree, to which the globe is strung by a covered wire, the moth flies against the net work, completes the electric circuit and is instantly killed, the body dropping into a receptacle beneath the globe. Mr. Frost thinks that one battery to an acre of trees will keep the moths under control, thus eliminating spraying and saving many dollars for equipment and fluid. If electric light wires are extended to the orchard tracts, as they are in the Spokane valley, the expense of batteries may be saved by making direct connection and using the commercial current. The cost of covering the globes with wire nets is a small item and any electrician can do the work. Growers in various parts of eastern Washington are preparing to equip their orchards with the new pest destroyers the coming season.

GRAND PRIZE FOR ELECTRIC SAFETY LAMP.

The British government announce that, in order to encourage the production of safe and efficient types of electric lamps for miners, a colliery proprietor has placed at their disposal the sum of £1,000 ($4866.65) to be offered as a prize for the best lamp or lamps fulfilling the requirements specified below.

Mr. Charles Rhodes (a former president of the Institute of Mining Engineers) and Mr. Charles H. Merz (a member of the departmental committee on the use of electricity in mines) have consented to act as judges. The conditions of the competition are as follows:

1. The competition will be open to persons of any nationality.

2. It will be in the discretion of the judges to award the whole of the prize for the lamp which they consider to be the best, or to divide the prize, or to make no award if no lamp appears to them to be of sufficient merit.

3. Lamps must be addressed care of C. Rhodes, Esq., at the Home Office testing station, Rotherham, England, and must reach the testing station not later than December 31, 1911. A spare globe should accompany each lamp.

The requirements which should be fulfilled by any lamps submitted for competition are as follows:

1. The lamp should be of sound mechanical construction, so as to withstand rough usage.

2. The lamp should be of simple construction and easy to maintain in good order and repair.

3. The lamp should be so constructed as to render impossible the ignition of inflammable gas either within or without the lamp.

4. The lamp battery should be so constructed that any liquid which it may contain cannot be spilled when the lamp is in use, and means should be provided for dealing with any gas which may be generated by the battery.

5. The materials used and the construction should be such that metals and other parts will not be liable to deterioration by corrosion as a result of the action of the "electrolyte," etc., used in the battery.

6. The lamp should be effectively locked so that it cannot be opened without detection.

7. The lamp should be capable of giving an amount of light not less than 2 candlepower continuously for a period of not less than 10 hours.

8. The light should be well distributed outside the lamp. A movable reflector to concentrate or to shield the light may be provided.

In addition to the above requirements, regard will be paid to (a) the first cost of the lamp; (b) the cost of maintenance; (c) convenience in handling, and (d) the weight of the lamp when charged and ready for use.

PRIMER OF APPLIED THERMODYNAMICS.[1]

Introduction.

The development of the steam turbine during recent years and the many increasing applications of producer gas on the Pacific Coast have led western engineers to dig again into their long forgotten textbooks and review subjects of by-gone college days long since forgotten. The subject matter of thermodynamics is not attractive or interesting, especially to young engineers. College students long since found this study so dry and lacking in interest to them that many nicknames for the study have been invented by them involving names more forceful than elegant. The study of thermodynamics or heat forces is essential, however, in gaining a thorough knowledge of the fundamental principles of the steam engine, the steam turbine, the gas engine, the air compressor and any other machine or device in which solids, liquids, or gases are used in developing or transmitting energy by heat.

By putting directly to the college student the question, why this lack of interest?, a very good reason is soon ascertained. The subject is usually given in the senior year. Three long years of study on the part of the student have brought him to his last year in college, and the course of thermodynamics greets him with long columns of integral signs and symbols. In his last year the student begins to realize that the bread-earning days are not far distant. He wants to put aside theory and get practical ideas. Toward the latter part of the senior year when the practical side arrives at last, he has but a few weeks left before graduation, and in the excitement of the closing days of his college career, he tenderly lays aside his dear thermodynamics book, hopefully trusting that kind providence will never again torture him with so many supposedly meaningless mathematical symbols for such a seemingly useless and theoretical subject.

It is the purpose of the following series of lectures to get at the applications of thermodynamics, explain them as briefly and simply as possible, and in so far as is possible accomplish all results without the use of any but the simplest mathematics. It is the opinion of the author that not only depth of the subject must be reached by the engineer, but the thorough mastering of the fundamental principles is essential. These fundamentals should be so thoroughly mastered that never again through life should the engineer have difficulty in grasping every possible application of the steam tables, adiabatic and isothermal expansion and entrophy. With this idea in view, the following series of lectures are designed and if they call forth a good healthy discussion, a more earnest desire among young engineers to seek the truth in their chosen profession, the author shall feel that his purpose has been accomplished.

First Lecture.

Heat—Temperature.

When we put our finger into a cup of warm water and then again into water formed by the melting of ice, a distinct sensation is felt in each case. Many years ago scientists and philosophers attempted to explain this sensation by assuming that a substance existed which they called "caloric," whose entrance into our bodies caused the sensation of warmth, and whose egress therefrom the sensation of cold. But heat, if a substance at all, cannot be similar to those substances with which we are familiar, for a hot body weighs no more than one which is cold. The calorists then, had to give a hitherto unknown property to their substance and maintained that "caloric" was a weightless fluid. This substance also had the property of filling the interstices of bodies and of passing between bodies over any intervening space. To illustrate, they said, caloric would fill the interstices of a body as water enters a sponge. Now, when we squeeze a sponge some of the water oozes out and wets our hands. The calorists assumed that the friction or rubbing of a body, with the hand, for instance, made the hand warm because friction was supposed to decrease the capacity of a body for holding "caloric," and as in the squeezing of the sponge, water oozes out, so caloric oozed out and made the hand feel warm. Davy, however, exploded this theory in 1799, when by rubbing two pieces of ice together, he actually caused the ice to melt. This evidently would be impossible under the caloric theory above stated, according to which friction caused capacity for caloric to be decreased. Yet here was evidenced the adverse. From time immemorial, men have considered that the force of truth is almighty, and yet how slow the human race is to overthrow an imperfect but well-established theory. For instance, so powerful was Sir Isaac Newton's grip on the scientific world that because he announced that no successful correction could ever be made for the uneven refraction of light rays in lenses, the whole world for fifty years thoroughly abandoned the idea of ever being able to use refractive telescopes, and consequently, during this period we find telescopic reflective mirrors used entirely. And so it was in the case of the theory of heat. Notwithstanding the all-powerful demonstration of Davy in 1799, it remained for Joule, nearly fifty years later to finally put forth the finishing data to forever overthrow the caloric theory and introduce the modern idea of heat. This eminent scientist constructed a machine in many respects similar to an ice-cream freezer, the essential difference being, however, that the machine was used to increase the heat in the liquid instead of cooling the same. Joule conceived the idea that heat was one form of energy. Should this be true, it should be mutually convertible. One of the easiest methods of measuring energy is the well known pile driver. Energy is definitely computed by weighing the hammer in pounds and multiplying by the distance in feet through which the weight falls. The result is foot pounds of energy. By a clever contrivance constructed somewhat on this principle, Joule measured the amount of energy absorbed in his machine and the consequent rise of temperature in the liquid. He soon established the fact that a definite number of foot-pounds of mechanical energy was equivalent to a definite number of heat units in the liquid. This experimental result is most important and is one of

[1] A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

the basic principles of modern engineering. Careful scientific measurements have proved that one British thermal unit, or B.t.u. of heat energy is equivalent to 778 foot-pounds of mechanical energy.

Heat may be communicated from one body to another in three different ways, namely: by radiation, conduction and convection.

It is a matter of common knowledge that when two bodies at different temperatures are separated by a transparent medium, such as air, or water, or glass, or ice, heat passes from the warmer to the colder irrespectively of the temperature of the intervening medium, except in so far as its transparency may in some slight degree be affected by the temperature. This process of transference from one body to another body at a distance through an intervening medium is called radiation of heat.

When two bodies are in contact, one with the other, heat is transferred from the warmer to the colder. This process is called conduction of heat. Convection is the transfer of heat caused by the rise of heated particles in a mass of liquid or gas. For instance, in the so-called "hot air" heaters the room is warmed by heated particles of air being conveyed by convection currents to various parts of the room. The transference of heat from a furnace to the boiler takes place by all these methods, radiation, convection, and conduction, while the heat is distributed through the mass of the water by convection. At present, however, the exact laws governing these methods of transfer are unknown.

One of the most striking and beautiful illustrations that can be cited from the great forces of nature in which convection currents are utilized is the non-freezing of our mountain lakes in winter, thus demonstrating the ever presence of a kind providence in protecting life, for in this case the lake trout are preserved. When the cold winter weather arrives the surface waters of our mountain lakes contract or become more dense. The surface waters thus becoming heavier sink below allowing the warmer waters to rise to the top. These in turn become cooled and sink, allowing the warmer waters again to rise. In this way convection currents are continually exerting themselves lowering the temperature of the entire lake waters. When the water is within 7.1 deg. F. of freezing solid, as if nature half repented for the crime about to be permitted, it has endowed the water with such unique physical properties that no longer does it grow more dense in cooling but on the contrary less dense, hence the convection currents are automatically stopped in time to keep the lake from freezing solid and water being a comparatively poor conductor of heat, but a thin coating of ice is formed.

Before going further into a discussion of the mechanical equivalent of heat, which, as we have seen, was first computed by Joule, it is positively necessary that we have a clear conception of the difference between "quantity" of heat and mere difference in "temperature." Let us conceive that we have before us a vessel containing 62.5 lb. of water at O deg. C. or just above freezing point and another vessel containing an equal amount of water at 100 deg. C., or just below boiling point. Conceive also that we have two pieces of lead each weighing 62.5 lb., the one at 0 deg. C. and the other at 100 deg. C. If you dip your finger into the hot water and touch the hot lead you will experience the same severe burning sensation, and yet if you mix the hot water with the cold lead and the cold water with the hot lead the remarkable result is obtained that in the former case the resultant mixture is very close to 97 deg. C., while in the latter case the mixture has but a temperature of 3 deg. C. Hence it is very evident that different bodies have different capacities for storing heat, and that "quantity of heat" and "temperature" are widely different conceptions. With the exception of hydrogen gas, water of all the physical substances, is capable of storing more heat, whereas lead is one of the poorer reservoirs of heat energy for a given rise in temperature.

From the above discussion it is readily seen that temperature is an indicator of the physical effect of heat rather than a quantitative means of heat measurement. In the strictest sense, then, the word heat is used to denote that something which the hot lead in the above illustration communicated to the cold water when the hot lead lost 97 deg. in temperature and the cold water was raised in temperature to 3 deg. C. Temperature on the other hand is a definite quality of matter, varying generally in any particular piece of matter when heat is communicated to it or taken from it, although we shall find some most important exceptions in which large quantities of heat may be added to a substance or taken therefrom without affecting the temperature in the slightest degree.

Next, then, in order that we may talk intelligently regarding "quantity of heat" and "temperature," it is necessary that we give at once the units in which we are to measure "quantity of heat" and "temperature."

In casting about for some physical substance to use in our definitions, almost any substance might have been selected, but as water is so widely distributed throughout the globe and can be secured comparatively easily in a pure state, scientists and engineers have made use of it for their unit definitions.

That amount of heat which is required to raise one pound of water from 62 deg. F. to 63 deg. F. is called one British thermal unit, or one B.t.u., and is universally used as the heat unit by American and British engineers. On the other hand, that amount of heat which is required to raise one kilogram of water from 15 deg. C. to 16 deg. C. is called one calorie, and is universally used by scientists, and is being more and more used among engineers.

We find by proper substitutions and calculations that

1 B.t.u. = O.252 Calorie.
1 Calorie = 3.97 B.t.u.

In the matter of temperature measurement three separate systems are in vogue and are the Fahrenheit, Centigrade and Reaumur. The first mentioned scale indicates the freezing point of water at 32 deg. F. and the boiling point at 212 deg. F., the second at 0 deg. C. and 100 deg. C., and the third 0 deg. R. and 80 deg. R., respectively. It is most unfortunate that the three separate scales should have attained such a hold upon the engineering and scientific world that

we should thus be compelled to be able to readily convert any one scale into units of the other.

The Fahrenheit scale although more cumbersome than the Centigrade is used almost entirely in engineering practice, while the Centigrade is used in scientific works and by engineers on the continent. The Reaumur is used in Russia and in distilleries and breweries.

In Fig. 1 will be found a diagrammatic representation of the three scales and their respective numerical

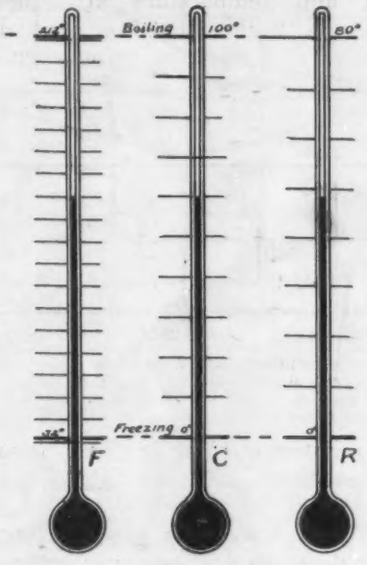


Fig. 1.

values at the two common points of calibration, namely: the freezing and boiling points of water. For strictly accurate transformation of the one to the other, however, we should deduce exact equations, so that any temperature on one scale can be quickly and accurately computed on the other. We shall, then proceed to deduce definite algebraic relationships of the one with the other.

Among the ancient Greeks, Euclid proved that if we have a triangle as shown in Fig. 2 with a line CE

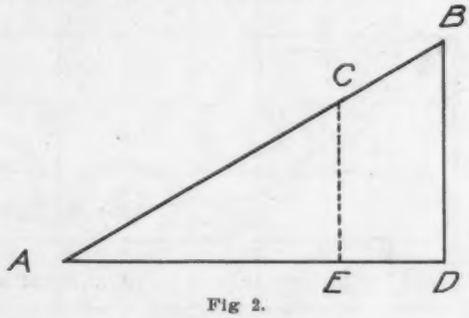


Fig 2.

drawn parallel to BD then the length CE would be to BD as AE is to AD or algebraically speaking:

$$\frac{AE}{AD} = \frac{CE}{BD}$$

Turning our attention now to Fig. 3 we have the same figure, only a little bit disguised.

Let us suppose we have two points A and B, fixed in the plane of the paper and that these points measure y_1 and y_2 units from the line X X and x_1

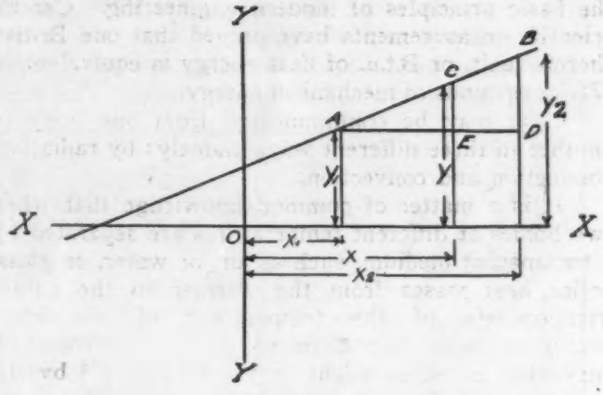


Fig. 3

and x_2 units from the line Y Y. Since these points are permanently fixed, the line A C B is permanently fixed, as two fixed points determine a line. Now let us take any point on the line A B such as C. Evidently, at any given position it will measure y units from the line X X, and x units from the line Y Y, and consequently under any given definite conditions its position is fixed. Looking at the figure we have

$$CE = y - y_1 \quad BD = y_2 - y_1$$
$$AE = x - x_1 \quad AD = x_2 - x_1$$

or substituting, we have

$$\frac{AE}{AD} = \frac{CE}{BD}, \text{ or } \frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

Returning now to our temperature scales let us derive a relationship between the Fahrenheit and Centigrade scales. We have two definite given conditions.

At freezing point of water $x_1 = 32$ deg. on Fahrenheit, which corresponds to $y_1 = 0$ deg. on Centigrade.

Also at boiling point of water $x_2 = 212$ deg. Fahrenheit, which corresponds to $y_2 = 100$ deg. on Centigrade. And in general let $x = F$ on the Fahrenheit scale correspond to $y = C$ on the Centigrade scale. Substituting we have

$$\frac{x - x_1}{x_2 - x_1} = \frac{y - y_1}{y_2 - y_1} \text{ or } \frac{F - 32}{212 - 32} = \frac{C - O}{100 - 0}$$

or $100\,F - 3200 = 180\,C$.

$$F = 9/5\,C + 32 \quad \ldots\ldots\ldots\ldots (1)$$

The student can similarly by proper substitutions derive a relationship between each of the other two possible combinations and find

$$C = 5/4\,R \quad \ldots\ldots\ldots\ldots (2)$$
$$R = 4/9\,(F - 32) \quad \ldots\ldots\ldots\ldots (3)$$

A simple but extremely accurate graphical method of computing corresponding numbers on the three temperature scales is very easily accomplished as follows: Take an ordinary piece of plotting paper as shown in Fig. 4. Lay off Fahrenheit units on the lower horizontal line, allowing 2 units per degree or 10 units for 20° F. Along the left hand vertical column lay off the centigrade scale with one unit per degree centigrade. If ordinary temperatures are to be measured, it is convenient to begin in the lower left hand corner with —40 as both readings of Fahrenheit and Centigrade scales

are numerically equal at this point. Next plat the boiling point of 212° F corresponding to 100° C and draw the line and instantly relationships are obtained for any other corresponding temperatures. The Reau-

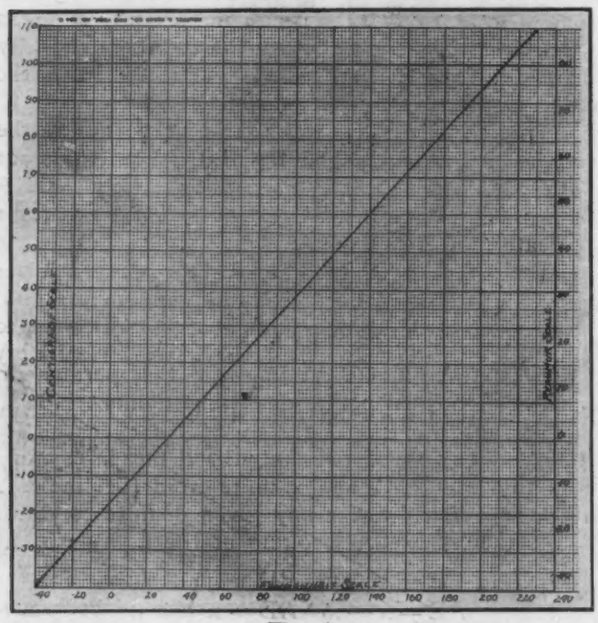


Fig. 4.

mur scale is next very easily added on the right hand vertical column. Begin its zero point corresponding to the zero horizontal line on the centigrade scale and its 80 degree point corresponding to the 100 degree point on the centigrade scale. Each series of 10 units on the paper will be found to correspond to 16 degrees Reaumur scale measurement. Smaller units are quickly interpolated and added to the scale. Should high temperatures be necessary for transformation any two points can be chosen instead of the freezing and boiling points in order to draw the straight line obtained above and the same accurate result obtained over the new range of temperature desired.

The following are a few useful temperatures corresponding to the Fahrenheit scale and can be easily checked from the formulas given above.

TABLE I.

COMPARISON OF THERMOMETER SCALES.

	Fahrenheit.	Centigrade.	Reaumur.
Absolute zero	—460.66	—273.70	—218.96
	0.	—17.77	—14.22
	10.	—12.23	—9.77
	20.	—6.67	—5.33
	30.	—1.11	—0.88
Freezing point	32.	0.	0.
Maximum density of water	39.1	3.94	3.15
	50.	10.	8.
	75.	23.89	19.11
	100.	37.78	30.22
	200.	93.34	74.66
Boiling point	212.	100.	80.
	250.	121.11	96.88
	300.	148.89	119.11
	350.	176.67	141.33

THERMOTWISTERS.

1. The normal temperature of the human body is 98.6° F. Express in Centigrade and Reaumur degrees.

2. Compute by equations given above at what temperature the Fahrenheit and Centigrade scales read alike. Similarly for the Fahrenheit and Reaumur scales.

3. Given that $y = mx + b$ is an equation which represents in general the three thermometer scales in which y or x can be either F, C, or R. Compute the two constants m and b by substituting corresponding values on scales for boiling and freezing point of water and thus deduce for yourself the three equations above.

ENGINEERING OPPORTUNITIES WITH FOREIGN NEIGHBORS.

Our immediate neighbors to the north and south are presenting ever broadening opportunities for engineering enterprise. The unexcelled increase in ex-

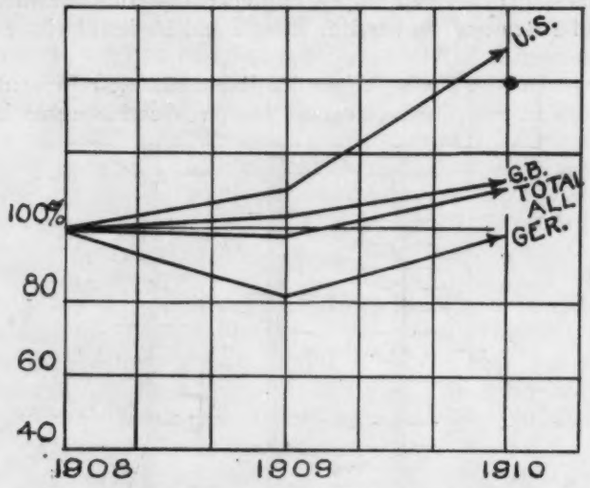


Fig. 1. Steepness of Individual Line Represents Increase of Imports Into Chile for Each Particular Country Shown.

ports to them from our Pacific Coast cities give a very striking illustration. Let us take Chile as an example.

The United States has been making substantial gains in nearly every division, with exceptionally large

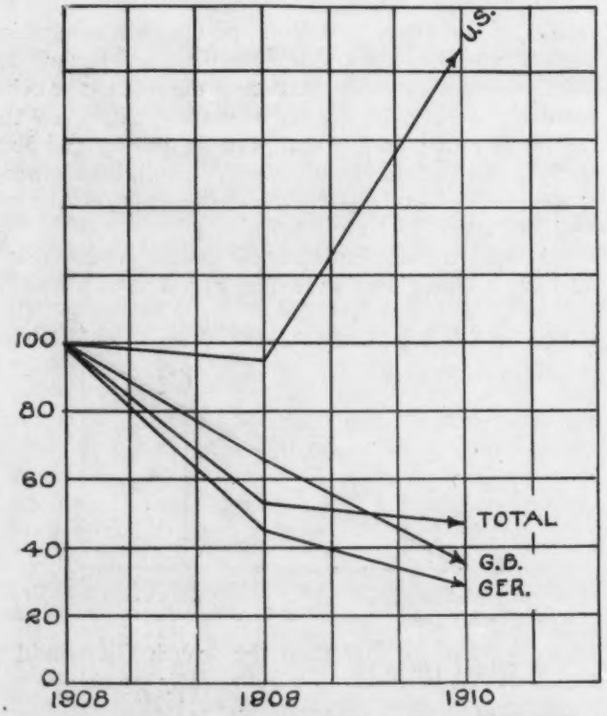


Fig. 2. Steepness of Individual Line Represents Increase of Oil Imports Into Chile for Each Particular Country Shown.

increases for mineral products, oils, coal, and machinery. The heavy increase in mineral products is principally in steel, bars, rods, plates, structural shapes and angles, while under the head of oils and coal, the greater gains were in kerosene, paints, oils, and

crude petroleum for fuel. The imports of American machinery show a substantial gain, while the United Kingdom and Germany show a decrease.

The following table shows the total imports, by classes, into Chile for the past three years and the share of the United States, United Kingdom, Germany, and France in that trade:

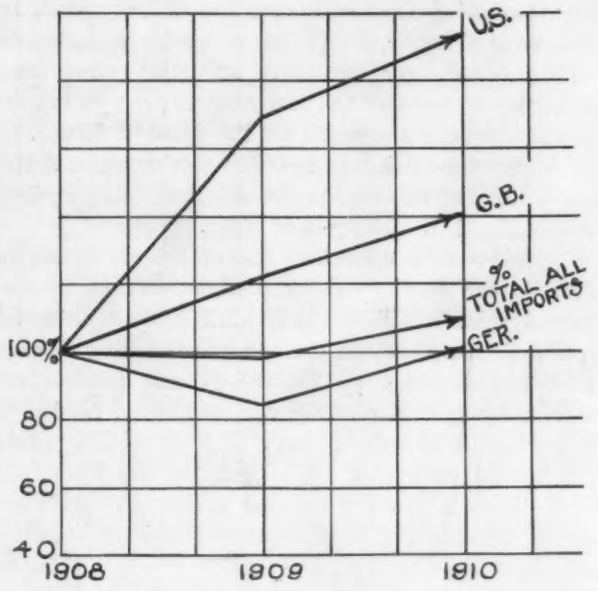


Fig. 3. Steepness of Individual Line Represents Increase of Machinery Into Chile for Each Particular Country Shown.

Mineral products cover iron and steel bars, plates, products include fruits, grains, lumber, tobacco, etc.

Other countries participating in the imports into rods, cement, building hardware, etc., and vegetable Chile to any degree were: Argentina, $5,477,808, of which $5,242,138 were animal products; Peru, $5,445,-989, made up principally of vegetable products and oils and coal; India, $4,018,250, of which $3,671,269 were textiles; Italy, $3,227,853; Australia, $2,720,656; Belgium, $2,464,941; Spain, $1,349,700; all other countries, $2,904,644.

Several hydroelectric power plants are being constructed, principally by German interests. So far as known there is but one plant in the country owned by American interests, and that is connected with the Braden Copper Co. near Rancagua, Chile.

German interests control a large proportion of the electrical plants of the country and are reaching out for the most available sites for hydroelectric plants. A German company secured a concession last year for the location of a water power plant on the Aconcague River above Valparaiso with a view to supplying power and light to the region above and about this city. They so dominate this business that it is difficult to introduce anything but German electrical machinery and supplies. It will take some hard work to get back what American interests have let slip from them in this line, and it would be well for American manufacturers in other lines to take notice and see that other interests are not handicapped in a similar way, for German manufacturers are after business in Chile in earnest and every possible effort is made to capture the whole trade.

A careful analysis of the consular report above gives some interesting notes, however, and shows that at least our American engineers are wideawake to the growing opportunities on the Pacific. Oil and machinery represent typical engineering products. Below is a table showing the relative increase of American influence in these matters. Figs. 1, 2 and 3 are interesting. The steepness of each curve represents the rate of increase of each country in the commerce of Chile for the past three years. In every case American influence is seen to be rapidly gaining. In fact gaining at such a rapid rate that before many years the predominating English and German influences must give way.

Class.	Year.	Total.	United States.	United Kingdom.	Germany.	France.
Animal products	1908	$6,786,839	$545,312	$741,848	$685,020	$489,184
	1909	10,065,394	431,261	678,632	738,969	776,459
	1910	9,272,578	568,771	753,683	689,618	943,142
Vegetable products	1908	8,540,045	1,212,894	1,654,475	1,570,225	302,939
	1909	10,508,948	1,299,001	1,493,931	1,704,323	402,995
	1910	11,797,492	1,318,763	1,676,703	1,911,614	449,857
Mineral products	1908	17,020,090	822,594	6,456,157	6,396,493	556,179
	1909	16,845,468	1,495,919	6,185,639	6,365,454	780,878
	1910	18,822,566	2,431,407	5,962,177	7,507,759	872,036
Textiles	1908	20,407,329	531,273	8,208,927	5,739,650	1,507,694
	1909	23,090,729	744,498	10,412,753	5,512,716	2,214,088
	1910	29,114,560	817,003	12,156,918	7,486,407	?2,637,177
Oils, coal, etc.	1908	16,990,077	1,961,432	5,949,173	1,013,519	48,795
	1909	16,532,359	3,332,720	7,365,206	864,816	34,837
	1910	18,777,322	4,147,655	8,691,669	1,037,557	78,243
Paper, etc.	1908	2,808,331	796,036	349,563	1,275,474	110,307
	1909	2,537,925	485,079	311,778	1,352,571	118,615
	1910	3,354,888	769,072	407,458	1,745,651	118,991
Wines and liquors	1908	1,883,792	13,185	467,781	265,279	540,985
	1909	1,956,006	8,236	466,306	234,964	613,728
	1910	2,582,401	18,222	596,567	348,751	772,756
Chemicals, perfumery, etc.	1908	1,983,176	207,722	420,964	887,006	358,547
	1909	2,016,405	232,282	479,511	817,347	353,295
	1910	2,325,534	298,628	613,639	847,966	394,625
Machinery	1908	19,336,529	2,502,349	6,014,590	9,068,898	283,234
	1909	10,174,882	1,396,477	3,987,823	4,122,729	196,098
	1910	9,508,683	2,724,965	2,739,225	3,266,020	310,967
Arms, etc.	1908	633,148	62,408	226,818	285,081	13,212
	1909	828,316	96,104	292,488	352,253	10,685
	1910	1,598,489	215,470	504,800	762,941	27,021
All other	1908	813,604	42,084	140,513	369,139	144,769
	1909	842,967	79,507	168,679	369,899	161,849
	1910	1,472,675	59,818	237,734	691,787	406,114
Totals	1908	97,202,960	8,697,289	30,630,809	27,555,784	4,355,849
	1909	95,399,399	9,601,084	31,842,746	22,436,041	5,663,495
	1910	108,627,188	13,369,774	34,340,573	26,296,071	7,010,929

TABLE I.

	Year.	Total. Increase.	U. S. A. Per cent. Increase.	Gt.Britain. Per cent. Increase.	Germany. Per cent. Increase.
All imports	1908	100	100	100	100
	1909	41.8*	11.4	4.	18.6*
	1910	13.9	37.7	7.9	17.2
Machinery	1908	100	100	100	100
	1909	47.4*	5.0*	33.8*	54.5*
	1910	6.5*	95.2	31.3*	20.8*
Oils, coal, etc.	1908	100	100	100	100
	1909	2.7*	70	23.8	14.7*
	1910	13.6	24.5	18.0	16.7

* Indicates decrease in percentage.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Crude Petroleum

The last decade has witnessed such startling advances in the use of crude petroleum due to its practically unlimited natural supply on the coast we can hardly realize what the immediate future may still have in store for this great industry. Recent unofficial reports show that the production during the first six months of the present year was beyond the 37,000,000 barrel mark. No less interesting is the compilation of statistics which show, also, that in spite of the low market price of oil, dividends for July amounted to the total of $693,038.56. It is also stated that in addition to this amount there are a number of large producers that paid dividends, but declined to make public announcement.

Last season witnessed one of the greatest forest fires in the history of our national forests. Careful investigation has shown that while some of these fires had their incipiency in the careless handling of campfires and the like, by far the greater portion were started by sparks from the coal and wood used in the heavy railroad traffic over the mountain passes. Further investigation on the part of the forestry officials has led them to the conclusion that the use of oil in locomotives is practically the only means of safe-guarding our national forests during an exceedingly dry season such as last year. The great transcontinental railroads of the northwest are giving the subject of fuel and power supply the deepest thought and consideration. It will not be at all surprising if within the near future a remarkable change will be undertaken, namely the electrification of the mountain passes and tunnels where practicable and when impracticable the entire use of oil as a fuel.

Much study and investigation is still being concentrated on the use of internal combustion engines. The great saving of this form of power development in Marine engineering is unlimited. The oils of the coast are even now being shipped by sea to all parts of the globe. The Panama canal and the still further development of internally fired engines for marine service certainly give a golden tinge to the great oil industry of the coast.

Primer of Applied Thermodynamics

The theoretical side of engineering is difficult to grasp. Each year there are dropped from our technical schools hundreds of engineering students who do not and seemingly cannot grasp the great fundamental principles. If this is true of those attempting to gain knowledge where every facility is offered, how difficult it must be for that great class of young men who, though longing for an opportunity to gain knowledge, are through misfortune unable to attend our great technical schools.

The study of Thermodynamics is imperative if one desires to master the fundamentals of the steam engine, the gas engine, the air compressor, and the

many other practical applications in which the transference of heat quantities is made use of.

The subject as usually presented, requires the use of the calculus. This is undoubtedly necessary for the fullest investigation. But the young man denied the opportunities of higher education may accomplish much without it, for many engineers testify that they have absorbed more real theory and practical knowledge from the steam tables and the excellent explanatory data given in the trade publications than from the severe mathematical treatises on the subject.

Elsewhere in these columns will be found the beginning of a course of lectures entitled, A Primer on Thermodynamics. The subject will be attacked from the practical man's point of view entirely. The use of calculus will be avoided wherever possible. The order of procedure will not be the same as usually undertaken. The order is one, however, that has been tried four years in the class room in one of our State Universities, and the testimony of young engineers now out in the field of struggle who received the course in the order that will be followed in this series of lectures, strengthens the author in his belief that, for western engineers at least, it is superior.

As set forth in the title of this series, only a beginning can be accomplished in this great study. About us, we see thousands of young engineers yearning for better and higher things. We see others in the allied professions who would like to grasp the fundamentals of Thermodynamics but have not the time to go to its depths, even though thoroughly trained in the use of higher mathematics. It is these two classes the Journal hopes to reach. The Journal feels that its mission is to be of some valuable assistance in spreading the truth in engineering. If this series of articles accomplishes this result in the slightest degree—yes—even if it succeeds in one single instance in helping some worthy young man to better himself in life, to feel a deeper, broader responsibility in his profession, we shall feel our efforts have not been in vain.

Engineering and Foreign Neighbors

The country of the Aztecs and the country of the ucas as set forth in the conquest of Mexico and the conquest of Peru have ever held the American boy spell-bound with the gorgeous descriptions of these ancient civilizations. The ever-living memory of Cortez and Pizarro resplendent in their victorious conquests has done much in awakening the constructive imagination of the American engineer in embryo. The strife and turmoil of our near neighbors to the south have had a strong influence, however, in killing the immediate application of many of these constructive dreams. So long as the question of political supremacy is decided by the sword, so long will the true commercial greatness of a country be dormant.

Our own country has been undergoing such a tremendous internal growth in recent years, its citizens have hardly had time to consider the engineering conquests in the sister republics to the south even now awaiting the triumphal entry of our engineers.

Long since have our American engineers realized and taken advantage of the opportunities in western Canada and to a large extent in Mexico. By casual inquiries in British Columbia and Mexico in regard to the designers and constructors of the present great electrical development in those countries, it will be found that they are engineers from the United States. It is flattering to the West to know, too, that Western engineers have almost entirely monopolized this work.

A new and almost unlimited field of opportunity now presents itself. The South American republics are just awakening to a sense of their commercial importance. Strife and discord are being laid aside, and the sword transformed into the plough-share, thereby accomplishing wonderful results.

Especially is this awakening being felt in the countries bordering on the Pacific. The nearness of the completion of the Panama Canal project has set the commercial activities of these countries fairly a-whirl.

Eleswhere in these columns will be found a consular report of the commercial activity in Chile, which is a typical example of the activity shown in the other Latin-American countries of the Pacific. It is seen that in the year 1908 an immense impetus was here received in the way of imports of machinery and the like, which immediately followed the realization of the Panama Canal opportunities for Chile. In the United States our engineers were so engrossed with gigantic internal development that as in all previous years, this foreign neighbor was almost overlooked.

What was the result?

Wide-awake German enterprise corralled almost the entire machinery import. The wonderful hydro-electric prospects were gobbled up and a firm hold secured on the commercial future of the country. Although the total imports into this country in the way of machinery have been less in the succeeding two years, yet it is surprising how wide-awake American enterprise has became to opportunities lost and efforts to secure now what should have been ours from the first.

In the article referred to are shown charts indicating the percentage of increase or decrease of imports in Chile each year since 1908. The steepness of the line for the particular case shown indicates the proportionate increase or decrease. The line for machinery imported from America shows a wonderful vitality. In every instance the American increase is far superior to our foreign competitors.

Let us awake to our natural birth right. Western engineers with headquarters in our Pacific coast cities should never again allow a foreign engineering foothold in the Western Hemisphere. A hundred years ago our forefathers sprung the Monroe Doctrine as to Ameican politics. Let us extend the Doctrine to engineering enterprise. The conquest this time will not come by threats of forcing to arms, however, but by keen, alert, American brains and figures. Let us oil up the "slide-rules."

PERSONALS.

A. C. Balch, of the Pacific Light and Power Company of Los Angeles, was a recent San Francisco visitor.

R. S. Buck, of Sanderson & Porter, of New York, is in the Pacific Northwest on engineering business.

C. C. Hillis, Pacific Coast Manager for the Electric Appliance Co., has returned from the Electrical Jobbers' Convention at Saratoga, N. Y.

E. V. D. Johnson, general manager of the Northern California Power Company, has returned to Redding after visiting the company's San Francisco office.

C. O. Poole, of Manifold & Poole, arrived at San Francisco from Los Angeles last Thursday on important electrical engineering business connected with hydroelectric power transmissions.

Ben D. Moses has accepted the position of instructor in Mechanical Engineering at the University of California. Mr. Moses will assist Jos. LeConte, hydraulic expert, in his University work.

Sydney Sprout, electrical engineer for the Siskiyou Light and Power Company, which has just purchased the Rogue River Electric Power Companys holdings in Southern Oregon, has returned to the scene of operations in Siskiyou County after spending several days at his San Francisco office.

Robert Mather of New York, who is chairman of the board of directors of the Westinghouse Electric and Manufacturing Company, arrived at San Francisco last week in his private car on a tour of the Pacific Coast. He will inspect his mining properties in Trinity County before leaving California.

Delos A. Chappell of Denver, who is at the head of the Nevada-California Power Company, and is interested in the Pacific Power Company, spent the past week at San Francisco conferring with his engineers in connection with the proposed 250 mile extension of the former company's transmission lines into Southern California.

W. McGlashan has assumed charge of the new office of the water division of the United States Geological Survey at San Francisco, which has taken the place of the two offices formerly maintained at Sacramento and Los Angeles. Preparations are being made for surveys of the water supply in all of the streams in the Sacramento Valley.

Arthur P. Davis, chief engineer of the U. S. Reclamation Service, J. R. Freeman, consulting hydraulic engineer, F. G. Baum, consulting engineer and J. H. Wise, assistant general manager of the Pacific Gas & Electric Co., recently made a trip to the mammoth Spaulding damsite of the Pacific Gas & Electric Co. A careful study of the foundation for the 275 ft. concrete dam is being made possible by means of diamond drills.

Gano Dunn, who for some years has been first vice-president, chief-engineer and a director of the Crocker-Wheeler Company, has resigned from that company in order to accept an important engineering and executive position. Mr. Dunn will sail shortly for Europe to attend, as President of the American Institute of Electrical Engineers, the meeting during the Turin Exposition of the International Electrotechnical Commission, to be held on September 7th, 8th and 9th, and also the following meeting of the International Electrical Congress.

S. B. Charters, professor of electrical engineering at Stanford University, has been elected chairman of the San Francisco Section of the American Institute of Electrical Engineers. The other members of the executive committee are: H. A. Lardner, Pacific Coast manager for J. G. White & Co.; F. F. Barbour, assistant to president Pacific Gas & Electric Co., H. W. Crozier of the Pacific Coast office of Sanderson & Porter and A. H. Halloran, managing editor of the Journal of Electricity, Power and Gas, succeeding W. A. Hillebrand who has resigned to become professor of electrical engineering at the University of Oregon, Allen G. Jones is secretary.

ELECTRICAL CONTRACTORS' NOTES.

Wm. Turner, an electrical contractor of San Francisco, recently spent a few days at Sacramento looking after his interests there.

The Pacific Fire Extinguisher Company have been awarded the wiring on the Bankers' Investment Building; contract price, $8500.

Frank Somers of the Century Electric Company of San Jose was at San Francisco last week with the Fraternal Order of Eagles in convention.

The San Francisco Electrical Works, H. P. Thayer, manager, is finishing up a large contract for wiring and electric motor installation at the D. Ghiradelli Company's chocolate factory on North Point street.

The Metropolitan Electrical Construction Company has just completed a big wiring contract on the New John Cort Theater on Ellis street. This firm is also doing the wiring for the new Alcazar Theater on O'Farrell street and the new Pantages Theater on Market street. C. S. Phillips acted as illuminating engineer in designing the lighting installations.

Arthur Uglow, who was formerly connected with the Savoy Theater, is chief electrician at the new John Cort Theater on Ellis street, which will have its opening Saturday, September 2. The electrical illumination of the house is on a magnificent scale, the indirect system of incandescent lighting having been adopted. Nearly six thousand lamps are used, there being more than one thousand concealed lights on the front of the building.

TRADE NOTES.

The General Electric Company has sold to the Pacific Gas and Electric Company for use with its additional Curtis turbine generating set, one C. C. 4, 125 kw., 2400 r.p.m., 125 v., shunt wound Curtis turbine exciter unit. To the Yuba Construction Company the following gold dredge equipment has been sold: One 200 h.p. dredging motor; one 30 h.p. winch motor; one 100 h.p., one 50 h.p. and one 30 h.p. pump motor; one 40 h.p. screen motor; one 50 h.p. stacker motor; one 25 h.p. monitor pumping motor; one 2 h.p. tool motor; two 5 k.v.a. transformers, and a switchboard.

Hunt, Mirk & Co. have sold to the Pacific Gas and Electric Company a Worthington surface condenser equipment of 25,000 square feet, with a 40,000 gallon Byron Jackson centrifugal circulating pump to be direct connected; American Ball angle compound engine for use in connection with the 12,000 kw. Curtis turbine generating set that is to be installed in Station C at Oakland. Also, to the San Francisco Gas and Electric Company, for installation at Station A, San Francisco, a 25,000 square-foot Worthington surface condenser for use with the new 15,000 kw. Curtis turbine which is being built.

Work is to be begun within a month on the new assembling plant of the Westinghouse Company in Emeryville, at Park avenue and Halleck street. S. G. Down, Pacific Coast engineer for the company, now in charge of the San Francisco office at the Pacific Building, is awaiting the final detailed plans and orders to begin work. It is expected that more than 100 electricians will be employed in the new shops, where all classes of electrical goods manufactured by the Westinghouse Company will be manufactured for market. This is to be the distributing point for the Western territory and the Orient. Twenty electrical experts are being sent out from the home plant at Pittsburg to superintend the establishment of the new plant.

INDUSTRIAL

14000 K.V.A. TRANSFORMERS.

About two years ago the General Electric Company shipped to the Great Western Power Company, a number of 10,000 k.v.a. transformers, these units being the largest manufactured at that time. Since the installation of these units, other operating companies have followed the example set by the Great Western Power Company and, at the present time, quite a number of transformers of this exceptionally large capacity are in operation at various places.

Still larger units and, in fact, the largest transformers by far ever constructed, have recently been shipped by the General Electric Company to the Shawinigan Power Company,

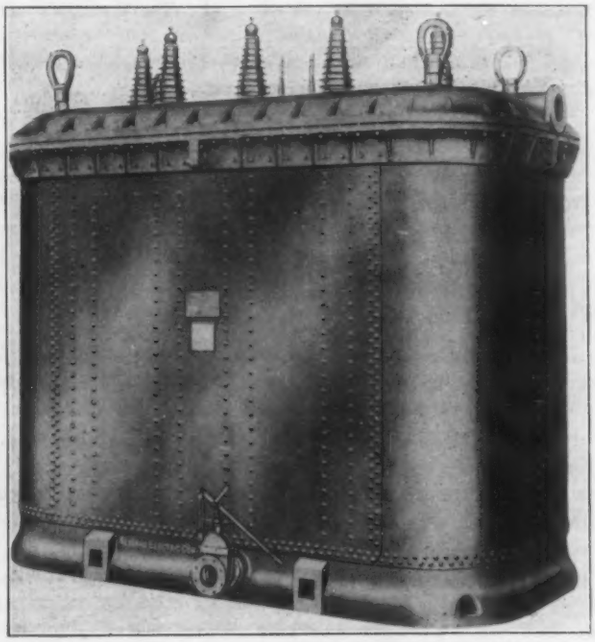

Fig. 1. 14,000 k.v.a. Transformer for Shawinigan Power Company.

at Shawinigan Falls, Canada. This shipment included four three-phase water cooled units designed for operation at a frequency of 60 cycles, two of them having a normal load capacity of 14,000 k.v.a. and the remaining two of 12,500 k.v.a. The 14,000 k.v.a. transformers will step the potential up from 6600 volts to approximately 100,000 volts for long distance transmission All four transformers have the same overall dimensions, occupying approximately 23 ft. by 8½ ft. floor space and being 18 ft. from the floor to the top of the

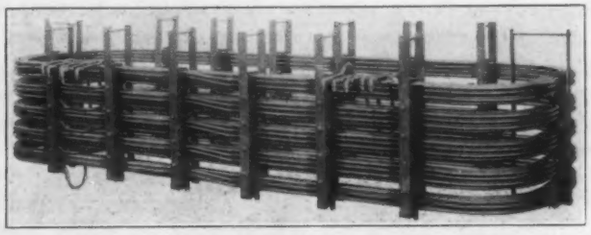

Fig. 2. Cooling Coils of 14,000 k.v.a. Transformer.

high tension terminals. The construction is exceedingly substantial, practically the only castings are the base and cover, the walls of the tank being made of steel plate ⅝ in. thick. On account of the great weights necessarily dealt with, the supporting frame work of the coils and core is built up of heavy "I" beams, the general appearance of the frames closely resembling the construction used in large locomotive frame work.

These transformers were designed to withstand a high potential test of 270,000 volts from the high tension winding to all other parts. Oil filled entrance leads are employed and these also were subjected to this high tension test. Although the striking distance of this test voltage in clear air is nearly 2½ ft., it is noteworthy that, when applied to these transformers after dark and with all lights turned out, no corona was visible.

There appears to be no practical limit in the design of transmission transformers either from the standpoint of capacity or voltage, as both of these conditions are limited by other features,—the transmission lines being the limit for potential and the transportation facilities for the size of the units.

TRADE NOTES.

The Trumbull Electric Manufacturing Co. has issued the August number of Trumbull Cheer. The pamphlet is replete with witty sayings, interspersed with Trumbull Cutouts and other apparatus handled by the company.

Proceedings of the second annual convention of H. M. Byllesby & Co. and affiliated companies have recently been published. The publication is replete with data regarding this energetic company and many interesting technical papers read at the convention are printed. The book contains over four hundred pages.

The Federal Telegraph Company, employing the Poulsen system, has been handling commercial business on the Pacific Coast since June 26th of this year between San Francisco, Los Angeles, San Diego, Stockton and Sacramento. Commencing with the first of September their service has been extended to Portland, Oregon and El Paso and Fort Worth, Texas, with immediate plans for reaching Kansas City. They are handling short messages, day and night letters at two-thirds the price charged by the regular telegraph companies.

Thirty-one members of The Buckeye Electric Company's sales force held their annual sales conference at Association Island during the week of August 14th. Accompanying the party were the wives of six of the men and a number of guests closely associated with the Buckeye organization. In summing up the last year's business and outlining future policies, L. P. Sawyer, general manager of the company, expressed complete confidence in the business outlook and mapped out a program of aggressive development for the coming season.

The Crocker-Wheeler Company of Ampere, N. J. announces the opening of a San Francisco office in the First National Bank Building, which will be ready for business on September 1st, 1911. This company is well known as a builder of h'gh grade electrical machinery of up-to-date design, and has been engaged in the manufacture of electric power machinery for twenty-three years. The company ranks as one of the largest electrical manufactures in the country and claims to be absolutely independent of any other concern.

Their Eastern business has, until recently, kept their plant fully employed, but now, having increased their facilities they are looking for a larger share of the Coast business.

The San Francisco office will carry a full stock of standard motors, generators and transformers, and requests that they be given opportunity to submit bids on proposed installations.

NEWS NOTES

FINANCIAL.

EXETER, CAL.—An ordinance has been passed calling an election on August 31 to vote $42,000 bonds for building a water system.

ALBANY, ORE.—The Continental Jewell Filtration Co. of New York has received contract for the installation of a filtration plant for the Oregon Power Co., at a cost of about $30,000. The new plant will be housed in a concrete structure, and adjacent to the new electrical power station.

ROSEBURG, ORE.—The Oregon Gas and Electric Co., operating in Oregon, California and other Western states, has filed trust deed and mortgages to secure a bond issue of $660,000, executed in favor of the Anglo-California Trust Co. of San Francisco. The company is installing a $60,000 plant in Roseburg.

OAKDALE, CAL.—The best bid for both the sewer and waterworks bonds was made by E. Rodden for the First National Bank and the sale of the bonds on this bid was authorized. Mr. Rodden's bid was a premium of $185 on the entire $20,000 of sewer bonds, and a premium of $51 on $25,000 of waterworks bonds. The other bid on the bonds was from the California Life Insurance Co. who offered to take $8,000 of the sewer and $10,000 of the waterworks bonds at par.

ORANGE, CAL.—The Chamber of Commerce has carried a resolution through recommending that a bond election be called for improving the city water system which the water superintendent estimates will cost about $48,000. Fire company officers estimate that $5,000 is needed to properly equip the fire department for effective fire fighting, including new hose, automobile fire truck and chemical engine. A petition calling for the bond election will be presented to the city trustees at the next meeting. It is believed that speedy action will be taken.

SAN FRANCISCO, CAL.—D. H. Foote, secretary of the Pacific Gas & Electric Company, has announced that the stockholders of the company will be called upon to vote at a special meeting October 23d on the increase of the bonded indebtedness of the company to $150,000,000, with a parallel increase in the capitalization of $160,000,000, all of the proposed increase to be common stock. About $60,000,000 of the bonds will be used for refunding the company's present issues, the balance being available for development work during the next ten years. Among the projects which will call for heavy expenditures is the extension of the South Yuba irrigation and power systems in Nevada and Placer counties, where $10,000,000 will be spent in accordance with plans now being passed upon by Maj. Arthur P. Davis and J. R. Freeman, who have recently been called in consultation on this subject. A million and half is being spent in the installation of steam power to supplement the hydroelectric system. Extensions now being made to the mains of the company's gas system in San Francisco will require the expenditure of approximately another million.

INCORPORATIONS.

MILES CITY, MONT.—The Miles City & Eladaka Telephone Co. has filed incorporation articles increasing its capital stock from $6,000 to $25,000.

SANTA ANA, CAL.—The El Modena Mutual Water Co. has incorporated with a capital stock of $43,000 and is to distribute water on 430 acres of land at El Modena. The incorporators are F. E. and E. V. Crawford of Pasadena and G. B. Lancaster of El Modena.

SACRAMENTO, CAL.—The North Sacramento Light and Water Co. has filed articles of incorporation with a capital stock of $50,000. The directors of the firm are: Marshall Diggs, Ray C. Waring and M. N. Williamson, of Sacramento; D. W. Johnston, of Los Gatos; G. A. Richardson, of Placerville; Charles E. Hollister and James T. Elliott, of Courtland.

LOS ANGELES, CAL.—The Malibu Tidewater Railway has been incorporated with $800,000 capital stock and with M. K. Rindge at its head. This company will operate between Santa Monica and Oxnard but it is planned to build extensions as soon as right of way can be secured. The directors are M. K. Rindgo at its head. This company will operate between Rindgo. N. D. Darlington, chief engineer, will have charge of the surveying and construction work.

ILLUMINATION.

OLYMPIA, WASH.—The J. C. Corbin Co. has been awarded the contract for the erection of a power plant for the Veterans' Home at Port Orchard.

WALLA WALLA, WASH.—The Pacific Power & Light Co. has been awarded the contract for furnishing power and light to this place for a period of ten years.

BURNS, ORE.—James D. Fellows has been granted a 25 year electric light franchise and will leave in a few days to purchase the necessary machinery for a high class plant.

COLTON, CAL.—G. W. Grow, superintendent and E. S. Bryant, Engineer of the Southern California Gas Company have petitioned the City Trustees for a franchise through Colton.

FORT FLAGLER, WASH.—W. E. Chase Engineering Co., of Spokane, Wash., will install an electric lighting system for the sum of $29,000. The bids for the work were opened June 15.

KLAMATH FALLS, ORE.—The Pelican Bay Lumber Co. will require about 800 lights in its new mill and will install a plant and have it in readiness for operation when the mill is ready to begin work.

STITES, IDAHO—D. E. Frank, manager of the Kooskia Milling and Power Co. has asked the council for a franchise for furnishing light and power to the town by stringing wires from the generating plant at the mill in Kooskia.

STOCKTON, CAL.—That Stockton is soon to be provided with an underground conduit lighting system, with electroliers throughout the business district, was indicated when Councilman Brisco's resolution to call for sealed proposals for the furnishing of the system was unanimously carried.

TRANSMISSION.

PORTLAND, ORE.—The Beaumont Land Co. has been granted a permit to construct an electric line in this district.

OGDEN, UTAH—The Davis & Weber Counties Canal Co. will soon begin the construction of a power plant south of the city, near Riverdale, for generation of about 5400 electric horsepower.

PORTLAND, ORE.—The Mt. Hood R. & P. Co. has completed plans for the $45,000, two story, reinforced concrete, terminal station on the O. W. R. & N. tracks near Williams avenue; three electric generators will be installed.

BELLINGHAM, WASH.—A contract has been entered into between the Western Canada Power Co. and the local company whereby 6500 h.p. will be imported before the first of the year. The Stone & Webster power lines will connect with the Canadian company lines at Sumas and from the boundary it will be brought to this city.

ELY, NEV.—An electric power plant is soon to be erected on Cleve Creek by the Telluride Power Co., according to plans made public by representatives of the company who have been in Ely for the past several days. It is estimated that it will develop more than 3000 h.p. The plant will be used in furnishing electric light and power to Ely and surrounding camps.

OLYMPIA, WASH.—L. B. Faulkner, manager of the Olympia Light and Power Co. has closed a deal for a right of way for the transmission line from the new reservoir at Lawrence lake to this city. The new power project will cost about $300,000. The reservoir to be put in will cost $30,000. When completed power will be supplied to the smaller towns and cities surrounding Olympia.

OAKLAND, CAL.—With their objective point as Oakland and with an ultimate hope of reaching San Jose and then coming up the peninsula via Palo Alto to San Francisco, the Blue Lakes Power & Light Company, a new corporation with general offices in Sacramento, is now laying a line parallel to that of the Bay Cities Power Co. across the hills from Lake County. At the end of 84th avenue, Elmhurst, the new line will branch off and enter San Leandro via Estudillo avenue or Juanita avenue. Norman Harcourt, chief engineer in charge of the local survey party, consisting of seven men imported from the East and who are stopping at the Crellin Hotel, said last evening that the new line would be ready to serve power to the people by December.

TRANSPORTATION.

SAN LUIS OBISPO, CAL.—A franchise has been awarded Walter Gould Lincoln for a street railway in this city.

ESTACADA, ORE.—The power plant of the P. R. L. & P. Co. was visited by a fire which caused the destruction of the engine, which will require a new one to replace the one destroyed.

PHOENIX, ARIZ.—Application has been made to the City Council by the Salt River Valley Electric Co. for a franchise to construct an electric railway through certain streets of Phoenix for a period of twenty-five years.

SAN FRANCISCO, CAL.—An order has been placed by the Oakland and Antioch Railway with the Westinghouse company for an equipment of electric cars. It is understood that the contract price approximates nearly a quarter of a million dollars. The cars are to be of the combination type to carry express as well as passengers, and will operate under 600 volts and have Pantagraph trolleys.

WALNUT CREEK, CAL.—Actual work on the proposed scenic road up the slopes of Mount Diablo has been started, a party of engineers and surveyors from Oakland appearing on the scene with maps and charts. The route laid out is up Walker Canyon. A trail has been blazed all the way to the summit, and this will be followed by the laying out of the road. This road will be completed long before 1915, and will afford opportunity for use by the visitors to the Panama-Pacific Exposition.

SACRAMENTO, CAL.—A traffic agreement has been entered into between the Santa Fe Railroad and the electric roads communicating with the Sacramento Valley towns, giving all points on the Central California Traction, the Northern Electric and the Vallejo and Northern roads direct connection with the Santa Fe. The principal points benefited are Lodi, Sacramento, Marysville, Yuba City, Gridley, Oroville, and Chico. Woodland will shortly be benefited by it through the building of the Sacramento-Woodland line,now under construction.

FRESNO, CAL.—The group of Fresno and Coalinga capitalists which is engaged in financing a railroad from this city to Monterey, by way of Coalinga, has outlined plans for three branch lines, according to President A. Albrecht of the company. One branch is to run from Hollister to San Jose, another from Hollister to Santa Cruz, by way of Watsonville, and another from Coalinga to Maricopa and Bakersfield. Efforts are now being concentrated on the plans for the main line, which is to be built by subscription of residents of Central California.

LOS ANGELES, CAL.—Two new cross-town electric roads are to be built in this city. The routes to be followed are: North and south line—From Bimini Baths south on Vermont avenue to Vernon avenue. East on Vernon avenue to the city limits. East and west line—From the city limits west on Jefferson street to Main. East from Main on Jefferson to Central avenue. South on Central avenue to 38th street. East on 38th street to Hooper avenue. Possibly from Hooper avenue east to 38th to city limits. This will mean about eight and one-half miles of new trackage.

MARYSVILLE, CAL.—The Pacific Gas & Electric Co., promoters of the proposed California Midland Railroad, connecting Marysville and Grass Valley, have taken over the stock of the Nevada County Traction Co., operating between Grass Valley and Nevada City and have an option for purchase of stock of the Nevada County narrow-gauge connecting Nevada City and Grass Valley with the Southern Pacific at Colfax. The acquisition of this stock is believed to mean a merger that will result in the building of the California Midland. Work is to begin within 60 days, according to announcement made here by George A. Aldrich. The road will be a broad-gauge, probably operated by electricity. It will connect Marysville, Hammonton, Spenceville and Grass Valley and Nevada City. The Nevada County narrow-gauge will give the line direct connection with the main line of the Southern Pacific. Eight miles of road have been graded between Marysville and Hammonton.

TELEPHONE AND TELEGRAPH.

REARDAN, WASH.—The Washington Consolidated Telephone and Telegraph Co. has been granted permission to build a line on Maple street.

LAKEVIEW, ORE.—C. H. Lee has taken the contract for the extension of the Nevada, California and Oregon Telegraph and Telephone lines to Lakeview.

PRINEVILLE, ORE.—The Oregon Central Telephone Co. has incorporated with capital stock of $50,000. Louis Doonar, O. R. Cook and N. W. Sanborn are the incorporators.

SPOKANE, WASH.—S. T. Spence of San Francisco has been awarded the contract for the completion of the Pacific States Telephone and Telegraph Company's building at Second Avenue and Stevens Street, at $129,760.

Pasco, Wash.—Estimates have been completed and plans are being made for installing a new system by the Twin City Telephone Co. According to Manager R. A. Klinge, about $30,000 will be spent. It is planned to place all wires under ground ultimately.

KELSO, WASH.—The Coweeman Telephone company will extend its lines on the Coweeman into Shanghai valley. The Company has bought the poles from Beck Bros., and as soon as the ground softens up, workmen will commence digging and setting poles.

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